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# Variation of Extreme and Fatigue Design Loads on the Main Bearing of a Front Mounted Direct Drive System

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The drivetrain of a 10 MW wind turbine has been designed as a direct drive transmission with a superconducting generator mounted in front of the hub and connected to the main frame through a King-pin stiff assembly. It is found that the initial generator weight of 363 tons must be reduced by 25% in order not to result in higher extreme loads on main and yaw bearing than the 10 MW geared reference drive train. A weight reduction of 50% is needed in order to maintain main bearing fatigue damage equivalent to the reference drive train. Thus a target mass of superconducting direct drive generators is found to be between 183-272 tons.

## Front mounted 10 MW superconducting generators

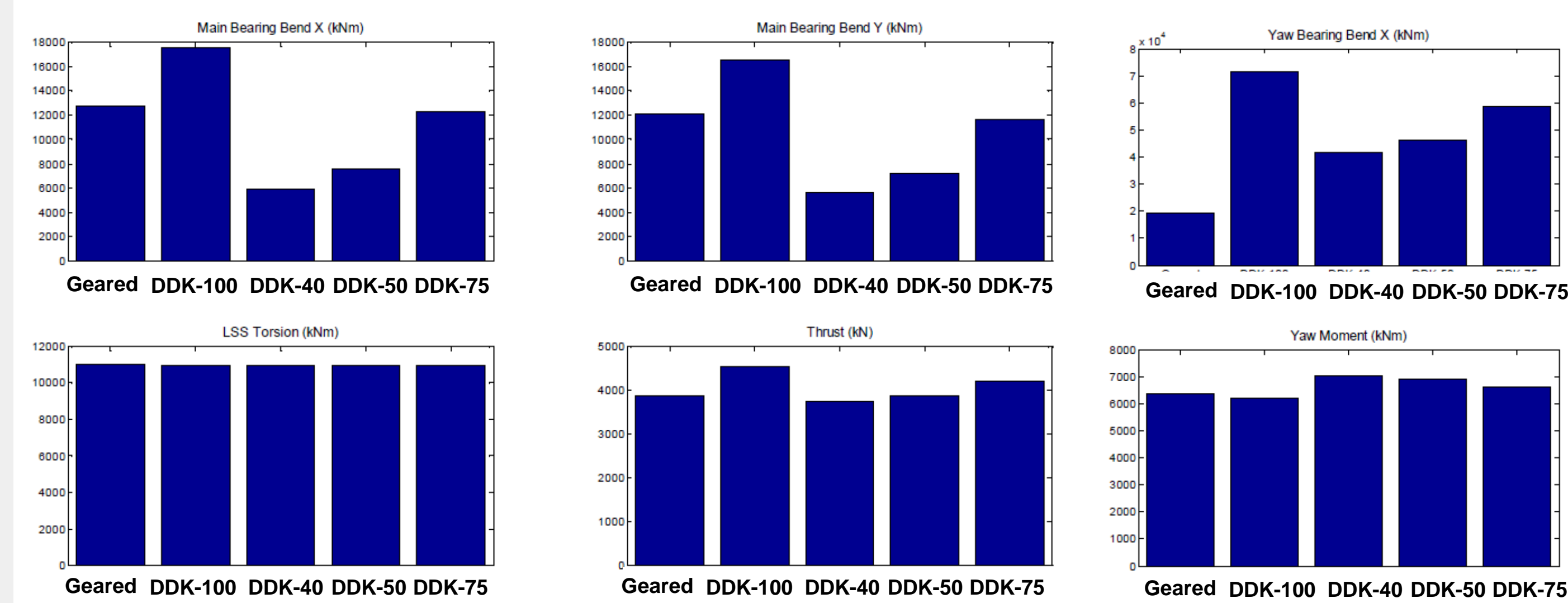
- Superconducting generators can provide high shear forces
- A 10 MW generator design based on  $MgB_2$  as start ( $m = 363$  t)
- Length scaled to obtain the 10 MW light weight design of GE based on the NbTi low temperature superconductor ( $m = 142$  t, table A2)
- King-Pin nacelle configuration with two main bearings (10-20 MW)
- 10 MW INNWIND.EU onshore reference turbine (table A1)
- Design Load Cases (DLC): 1.2 Normal operation, 1.3 Normal operation under extreme turbulence and 2.3 Gust + Grid loss

## Results & Discussion

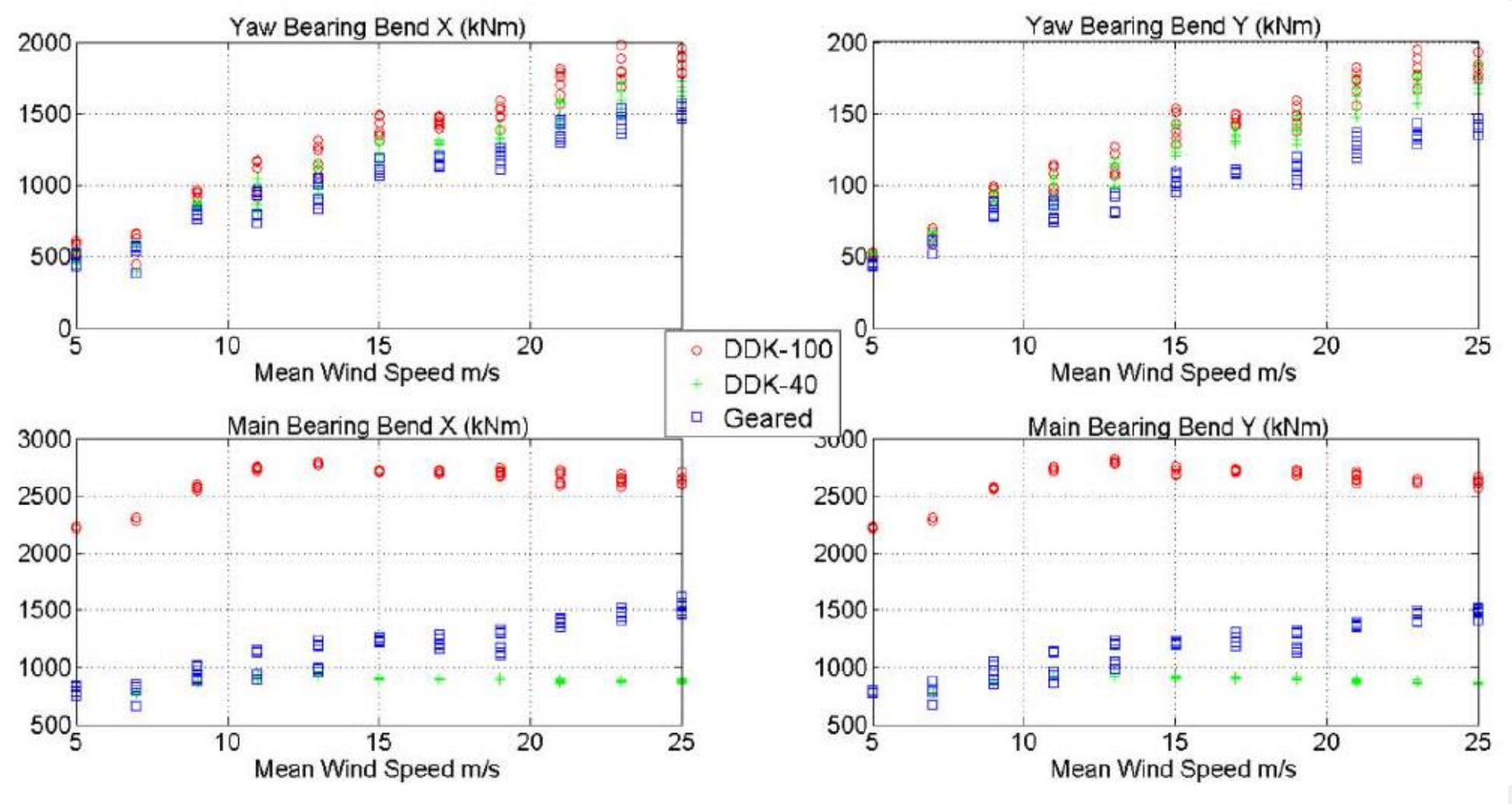
- Extreme loads of DLC 2.3 on main and yaw bearing are shown for  $m = 40, 50, 75$  and 100% of initial generator mass as well as reference medium speed drive train in fig 2 and 3. A reduction to 75 % mass gives equal main bearing extreme. Yaw bearing extreme are high, but within the design envelope.
- Fatigue loads of DLC 1.2 on yaw and main bearing are shown in figure 4. A reduction to 50 % is needed to obtain main bearing fatigue similar to the reference medium speed drive train.



## Extreme DLC 2.3



## Fatigue DLC 1.2



## Conclusion

The mass of the front mounted superconducting generator should be reduced to 75% to provide equal extreme loads, whereas the fatigue load on the yaw bearing indicate a reduction to 50 %. Thus aero-elastic simulation indicate a target mass of 183-272 tons.

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